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# MULTIMEDIA UNIVERSITY

## FINAL EXAMINATION

TRIMESTER 1, 2019/2020

**ERT3046 – MACHINE VISION**  
(RE)

24 OCTOBER 2019  
2.30 p.m – 4.30 p.m  
(2 Hours)

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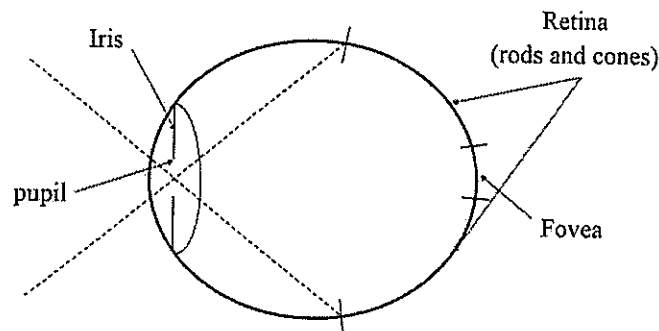
### INSTRUCTIONS TO STUDENT

1. This Question Paper consists of 5 pages with 4 Questions only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

### QUESTION 1

- a) In a camera, the lens has a fixed focal length. The focusing at distance is achieved by changing the distance between the lens and the imaging plane. In the human eye, the distance between the lens and imaging region (the retina) is fixed. The focal length needed to achieve proper focus is obtained by changing the shape of lens as shown in **Figure Q1(a)**.

Propose the right diameter range of the smallest printer dot so that the eye can discern on the paper page on which the printer black dot is 0.4 meter away from the eyes. In geometric terms, assume that visual system stops to detect the dot when the image of the dot on the fovea becomes smaller than the diameter of one receptor in the area of retina. The fovea can be modelled as a circular array of diameter 4 mm; the cones and spaces between the cones are distributed uniformly throughout the array with array of size 500 by 500 elements (pixels). [10 marks]



**Figure Q1(a)**

- b) (i) What is Bit Plane Sliding for 8-bit image? [3 marks]
- (ii) In **Figure Q1(b)**, it shows image A with image size of 4 pixels by 4 pixels. Find the Least Significant Bit (LSB) plane, Second Bit Plane, Third Bit Plane, and Most Significant Bit (MSB) plane for the image. [6 marks]

14	9	11	17
13	11	8	1
0	12	7	5
2	15	13	14

**Figure Q1(b)**

- c) **Figure Q1(c)** shows an image where the objects are marked as dark grey shaded. Elaborate the result of morphological *CLOSING* on **Figure Q1(c)-(1)** using the structuring element (S) as shown in **Figure Q1(c)-(2)**. [6 marks]

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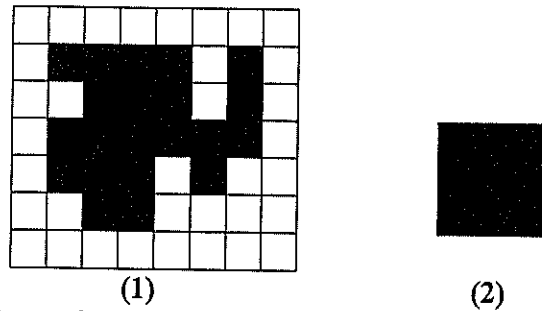


Figure Q1(c): (1) Binary Image, (2) Structure Element (S)

## QUESTION 2

- a) Calculate the output pixel values (only the inner  $6 \times 6$  part) on the segment 8-bits digital image as shown in **Figure Q2(a)** after it is filtered by
- (i) A  $3 \times 3$  Prewitt mask; [9 marks]
  - (ii) A  $3 \times 3$  median filter [6 marks]

0	0	0	0	0	0	0	0
0	0	15	0	0	0	0	0
0	0	0	0	0	19	17	0
0	0	0	0	23	24	10	0
0	13	0	0	25	24	14	0
0	0	0	0	25	5	5	0
0	0	0	0	23	23	23	0
0	0	0	0	0	0	0	0

Figure Q2(a)

- b) (i) What are the limitations of the quad tree in representing an image? [5 marks]
- (ii) Given **Figure Q2(b)** which shown the *quad tree* representation, reconstruct the original image by marking the object of interest. [5 marks]

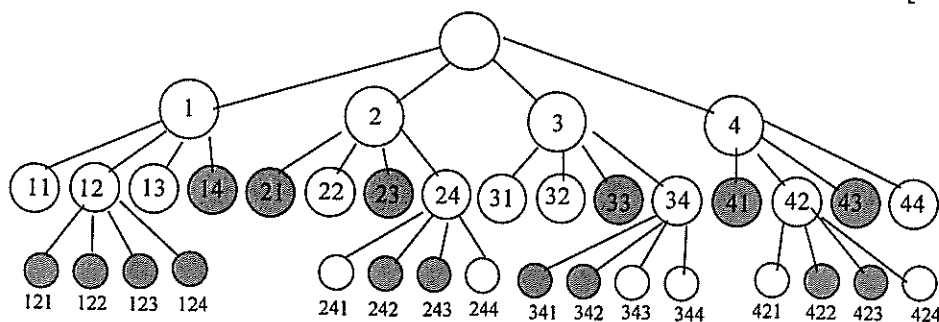


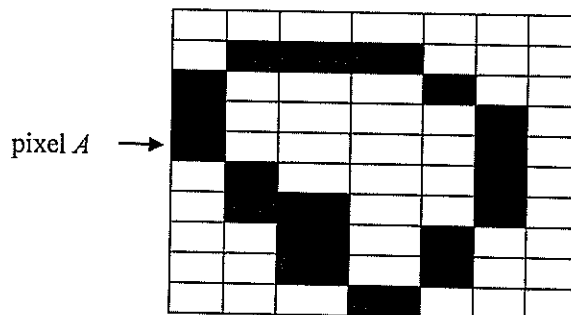
Figure Q2(b)

1	2
3	4

Continued...

**QUESTION 3**

- a) Shape of object representation has always been an important topic in image processing and computer vision. In order to detect the shape of the object, Contour plays a key role. Applications of shape recognition can be found in many areas such as medicine, manufacturing, defense and many others. Chain code techniques are widely used to represent an object as they preserve information and allow considerable data reduction. Suggest an effective chain code algorithm to detect contour for the binary object and also this chain code is used for machine learning. [4 marks]
- b) **Figure Q3(a)** shows the contour of an object as indicated by the dark pixels. Determine the freeman chain code:
- 8-direction chain code of the contour starting from pixel *A* measured in **clockwise** direction. [4 marks]
  - Difference code** of the contour if we assume circular sequence. [3 marks]
  - Refer to (i) with **315° rotation**. [2 marks]

**Figure Q3(a)**

- c) The gray level co-occurrence matrix  $P[i, j]$  is defined by first specifying a displacement vector  $d = [dx, dy]$  and counting all pairs of pixels separated by  $d$  having gray levels  $i$  and  $j$ . Based on the image as shown in **Figure Q3(b)**.
- Create the co-occurrence matrix for displacement  $d = [0, 1]$ . [4 marks]
  - Create the co-occurrence matrix for displacement  $d = [-1, -1]$ . [4 marks]
  - Analyze the energy and contrast levels for the co-occurrence matrix obtained for displacement  $d = [-1, -1]$ . [4 marks]

1	0	1	1	1	0
0	2	1	1	2	0
0	1	0	2	0	1
1	2	0	2	1	0
0	0	1	0	2	2
1	0	0	1	2	0

**Figure Q3(b)**

Continued...

**QUESTION 4**

- a) The recall of a Document retrieved (DR) system is the number of relevant documents retrieved by the system divided by the total number of relevant documents in the database. And the precision of a DR system is the number of relevant documents retrieved divided by the total number of documents retrieved. An international image database contains 200 sunset images that would be of interest to the user and that the user hopes to match the query. If the system can retrieve 150 of those 200 relevant images and 100 other images of no interest to the user, what are the finding results for recall and precision. [6 marks]
- b) Given training sets for 2 classes, Class X and Class Y as shown in **Table Q4(a)** and **Table Q4(b)** respectively. An unknown feature vector  $x = \{0.42, 0.23, 0.77\}$  is entered by a user to be classified into one of the specified classes. Determine the classification output using the
- nearest class mean classifier [3 marks]
  - nearest neighbour classifier [3 marks]
  - 3-nearest neighbour classifier [2 marks]
  - 5-nearest neighbour classifier [2 marks]

**Table Q4(a)**

Class X			
	f1	f2	f3
X1	0.36	0.35	0.41
X2	0.65	0.41	0.56
X3	0.56	0.32	0.51
X4	0.77	0.33	0.72
X5	0.64	0.39	0.81

**Table Q4(b)**

Class Y			
	f1	f2	f3
Y1	0.34	0.15	0.15
Y2	0.41	0.23	0.55
Y3	0.45	0.17	0.77
Y4	0.48	0.25	0.79
Y5	0.42	0.27	0.69

- c) **Table Q4(c)** shows a confusion matrix for a character recognition problem attempting to classify characters from 'A' to 'G'. Altogether, there are 600 feature vectors used to represent 600 alphabets. 'R' indicates 'reject' class. From the confusion matrix,
- how many inputs labeled as 'B' which are misclassified as 'D'? [1 mark]
  - which input alphabet produces the most classification error? [2 marks]
  - calculate the error rates for all the inputs. [2 marks]
  - compute the reject rate for the classifier. [2 marks]
  - calculate the overall error rate. [2 marks]

**Table Q4(c)**

Class j, output

True object Class i	'A'	'B'	'C'	'D'	'E'	'F'	'R'
	95	2	0	0	1	1	1
	0	97	0	1	2	0	0
	0	0	98	0	0	1	1
	0	2	0	96	0	2	0
	0	0	0	2	96	0	2
	0	0	3	0	0	97	0

**End of Paper**